tion to the consideration of that part of the osseous system. Notwithstanding the generosity of the authors in allotting such a goodly share of their space to the treatment of this part of their subject, it has materially suffered, in common with the other systems of the economy, by the too extensive condensation of matter which characterizes the entire volume. Space will not permit us here to show the numerous instances wherein this is evident, and an example or two must suffice. As an instance, we fail to discover even a mention of such structures as are presented us in the vestiges of a pelvis in the whales and other marine mammals; and a similar omission applies to the limbless Reptilia, as in Ophisaurus, for example. Nor (were these well-known facts alluded to) would the absence of external limbs imply that 'pectoral and pelvic arches are also wanting,' as our authors would have us believe (p. 87). And in regard to these vestiges of organs, and rudiments of the same, we are, in view of the fact of the highly important part they play in general morphology, compelled to deplore the exceedingly slight attention they have had bestowed upon them throughout the book.

Without the assistance of some such handbook as Parker's 'Zoötomy,' we are quite certain that the special student would find but little to serve him in the chapter devoted to the musculature of the trunk and its appendages, for the subject has been generalized to the last degree; nor is this section entirely free from error, as, to instance, we are told that 'no trace of a transversalis can be distinguished' in birds, — a statement that is by no means true, for a well-developed one is found in Apteryx, and this muscle is also found in some of the higher groups.

It will be out of the question to even enumerate the many slips that have been allowed to creep into the section devoted to the 'Nervous system,' certain portions of which must be read with great caution by the student, who perhaps may have to rely upon this manual as final authority.

So far as the defects among the figures are concerned, one of the principal ones to be noted is the inaccurate representation of the lancelet on p. 247, as compared with the far more correct drawing of the same animal on p. 114. Aside from these strictures, however, and many others that could be made, this work, with its long list of brilliant, and for the most part accurate, woodcuts, some of which are even colored, greatly enhancing their usefulness, its excellent bibliographical references at the end of each section, and its list of general works following the preface, and finally its admirable arrangement and clearness of diction, will be sure to commend itself to English students and readers of the subject of which it, as a whole, so ably treats. R. W. S.

THE LIFE OF HAMILTON.

EARLY in the third volume of *Science*, at p. 23, we left Hamilton at the age of twenty-seven, young in years, but with the foundation of that superstructure, which is and always will be the marvel of mankind, well and deeply laid. Nothing can be of profounder interest than, in this second volume of his life, to watch the completion and growth to maturity of that imposing intellectual edifice so ably delineated by the accomplished author, whom Hamilton had nominated as his literary executor.

Mr. Graves finds enough in a year of Hamilton's life for a single sizable chapter, if not for more. So important an event to Hamilton as his marriage is given the prominence it ought to have: in fact, subsequent events justify his biographer in terming it 'a crisis of his life.' As might be surmised, the period of his courtship of Miss Bayly was no less a period of his courtship of the Muse; but it was not with Hamilton as it would have been with a mere poet, a period devoid of intellectual activity in other directions. His head was full of the mathematics of conical refraction, while his heart craved the satisfaction of that complete consent, long delayed, which he prized above every thing else.

On the whole, this book, as well as its companion volume, is a most diffuse one — at least, it so seems; but its compiler might well have made it even more so without undergoing in the long-run any charge of error in judgment; for every scrap of even meagre information becomes of importance, no one can tell how great, when related to a man like Hamilton, of whom it may more truly be said than of any other man of the present century, that his highest fame is still of the future. While the slow progress of the quaternion method is not a little remarkable, Hamilton appears to have been himself conscious that this might be the case, and to some extent foreshadowed it, somewhere speaking of the mathematicians of a thousand years hence, and their gratitude to him for the discovery of the new calculus.

We have nothing but the highest praise for Mr. Graves's delicate and trustworthy descriptions of Hamilton's character, and the incidents of his life. We have also to thank him for the charming glimpses he gives us of other distinguished names, in the space allowed their letters: what we see of

Life of Sir William Rowan Hamilton. Vol. ii. By ROBERT PERCEVAL GRAVES. London, *Longmans, Green & Co.* 8°.

Sedgwick, De Morgan, Maria Edgeworth, and a number of others, leads us to the strong wish that their correspondence might have been presented in even greater fulness. We have, indeed, the promise of an extended correspondence between Hamilton and De Morgan in the appendix to the succeeding volume of Hamilton's life. Mr. Graves has considerately provided indexes to both these volumes with a minuteness to suit the most exacting librarian: their thoroughness, in fact, nearly doubles the value of his work. The possibility of a collection of the strictly scientific and technical correspondence of Hamilton has already been hinted at, and will, on the completion of the present work, supplement this literary biography in a most important direction. Still beyond that, are the abounding mathematical remains of Hamilton, to edit and publish which in proper form would require the work of a genius little inferior to that of Hamilton himself. Mr. Graves promises to complete his biography in the next succeeding volume: let us hope that his promise is not well grounded, and that he will give us a fourth.

THE Young-Helmholtz theory of color-sensation has recently been put to the test of direct experimental proof by Herr Frithiof Holmgren (*Verhandlungen der physiolog. gesellschaft zu Berlin*, 1886, No. 18). As is well known, the theory is that the retina contains three sets of nerve-elements, each set capable of responding to the stimulus of a single color alone; and that the three colors which correspond to three sets of nerve-elements are green, red, and violet. These are the primary colors, and our sensation of all others is due to the simultaneous excitation of nerve-elements of different sets. Now, it is possible to produce a point of light so minute that its image on the retina shall have no greater dimensions than those of a single nerve-element or cone. If such a point of light in any color of the spectrum be examined in such a way that its image falls in turn upon different parts of the retina, it will, if the Young-Helmholtz theory be true, be seen only as red, green, or violet. If one of these primary colors be chosen for examination, it will appear in its own shade or not at all; but, if any other shade is employed, it will be resolved into its primary elements, and seem red, green, or violet, according to its composition and the particular cone on which it falls. The results of Holmgren's investigation were in entire accordance with the theory; red, green, and violet (indigo-violet) were unchanged; yellow appeared red, green, or colorless, in no part of the field distinctly yellow; blue was resolved similarly into green and violet. Further experiments, with a view to determining how many cones must receive simultaneous stimulus to produce the sensation of a particular color, show that yellow is seen as red or green even when the retinal image is considerably smaller than the section of a cone; while, to be seen as yellow, the image must be large enough to cover two or three cones.

— In a paper read before the chemical section of the fifty-ninth versammlung deutsch. naturforscher zu Berlin on the 23d of September, Herr Liebreich calls attention to the curious fact that certain chemical reactions, which proceed readily enough under ordinary conditions, are delayed or fail altogether when the liquid reagents are in the meniscus of a narrow tube. Herr Liebreich is inclined to regard this phenomenon as due to cohesion, and to conclude that certain reactions may be delayed, or permanently prevented from taking place, by the action of this force. Whether this be the true explanation or not, the fact is a very interesting one, and likely to be of the highest importance in its bearing on physiologico-chemical processes, which go on in the capillaries of the body. Many reactions which are readily effected in the laboratory may be altogether impossible in the living organism; and, since the character of the capillary walls may be of considerable influence, reactions which give normal results in the healthy organ, may yield quite different products or be entirely suppressed when the organ is diseased.

— A thesis on the geology and vein-structure of south-western Colorado, by Prof. T. B. Comstock of Champaign, Ill., lately published in the Transactions of the American institute of mining engineers, is one of the few detailed geological studies of a western locality, not the work of a government surveyor. It contains a general account of the geology of the region, in greatest part from original observations, and examines with especial care the succession of the volcanic rocks and the phenomena of mineral veins. The division of the paper that will perhaps excite most comment is the one that contains the author's views on the relation between the direction and the minerals of the veins in the Redpeak district. Six zones of mineral veins radiate from the peak as a centre, as follows: N. 38° E., arsenical; N. 79½ E., bismuth; S. 34½ E., galena-gray copper; S. 35 W., antimonial; S. 76½ W., argentiferous galena; N. 36½ W., silver sulphuret. Between these mineral zones there are wedge-shaped barren areas, which begin to be particularly noticeable along the course of the Animas River, skirting around the peak. Reference is made to the criticisms of Professor Ihlseng, who does not accept Mr. Comstock's views.